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Geospace Dynamics Constellation (GDC) Project

NASA/GSFC Code 460

Representative Instrument Contract Data Requirements List (CDRL)

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

Check https://ipdtdms.gsfc.nasa.gov to verify that this is the correct version prior to use

Representative Instrument CDRL
Signature/Approval Page

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Preface

This document is a Geospace Dynamics Constellation (GDC) Project configuration control board (CCB) controlled document. Changes to this document require prior approval of the GDC CCB Chairperson or designee. Proposed changes shall be submitted in the GDC Technical Data Management System (TDMS) via a configuration change request (CCR) along with supportive material justifying the proposed change. Changes to this document will be made by complete revision.

All of the requirements in this document assume the use of the word "shall" unless otherwise stated.

Questions or comments concerning this document should be addressed to:
GDC Configuration Management Office
Mail Stop: 460
Goddard Space Flight Center
Greenbelt, Maryland 20771

Change History Log

Revision	Effective Date	Description of Changes
Revision -		

Table of TBDs/TBRs/TBSs

Action Item No.	Location	Summary	Individual/ Organization Actionee

1.0 INTRODUCTION

This representative Contract Data Requirements List (CDRL) is to be used to give proposers insight into the types of data requirements that will likely exist in the final version of the Geospace Dynamics Constellation (GDC) CDRL.

The GDC baseline CDRL provides specific information on the deliverable items to be listed in the Contract Statement of Work (SOW) for selected investigations. The CDRL may be tailorable to the specific instrument: based on contract value and instrument type.

The table below provides a listing of all contract deliverables with the following information:

ID: A sequential numerical identifier for each item.

Title: Provides the Title of the deliverable item.

Schedule: Provides the fixed or relative date or time that the deliverable is required.

Action Required:

A = **Approval -** Documents in this category require review and approval by GSFC or its designated representatives prior to use or implementation. GSFC shall approve/disapprove within 10 working days of receipt. Requirements for resubmission shall be specified in letter(s) of disapproval.

R = Review - Documents in this category are to be reviewed within 10 days by the GSFC or its designated representatives in order to determine contractor effectiveness in meeting contract objectives. When Government review reveals inadequacies, the contractor may be requested to correct the inadequacies. The developer can continue with the associated work while preparing a response to the GSFC comments unless directed to stop work.

I = **Information -** Documents in this category are informal and are for information only. No Government response is required.

AFR = Available For Review - Documents in this category are to be available at the contractor's facility for review upon GSFC's request.

1.1 Program Plans and Data

Investigators shall prepare and submit the plans and documents as specified in the CDRLs. Additional documents that are not included in this CDRL shall be made available if required. All plans and documents shall be distributed electronically.

1.2 Information, Data, Records and Storage

Investigators shall establish a method to provide access (via Internet) to authorized GDC Project personnel for working data products. A GDC or Investigator electronic database system, or a combination of both can be used. If an investigator database is used, access protection for the system shall be maintained, including an access control list for all authorized GDC Project personnel.

2.0 CDRL SUMMARY

PROJECT MANAGEMENT			
ID	**Title**	**Schedule**	**Action Required**
PM-1	Configuration Management Plan	Preliminary Due 90 days after contract award Baseline two weeks prior to ISRR	R
PM-2	Detailed Schedule (Inputs to IMS)	Due by the 5th working day of every month starting 2 months after contract award	I
PM-3	Monthly Contractor Financial Management Reports (533M)	Due not later than the tenth (10th) working day following the close of the contractor's monthly accounting period	R
PM-4	Quarterly Contractor Financial Management Reports (533Q)	Due quarterly on the 15th of the month prior to the quarter being reported	R
PM-5	Instrument Monthly Report (IMR)	Due the 2nd working day of each month	R
PM-6	Input to GDC Monthly Status Report (MSR)	Due the 2nd working day of each month	R
PM-7	Instrument Weekly Status Report	Due weekly	I
PM-8	Instrument Peer Reviews	Review List Preliminary: 2 months prior to ISRR Baseline: 2 months prior to IPDR Draft Agenda: 2 weeks prior to Review Data Package: 7 days before Review Report: 10 days after Review Action Item Summary: As generated	I
PM-9	Instrument System Requirements Review (ISRR)	Draft presentation due 1 week prior to review Final presentation due at review	R
PM-10	Instrument Preliminary Design Review (IPDR) Package	Draft presentation due 1 week prior to review Full Data package due 1 week prior to review	R

PROJECT MANAGEMENT			
ID	**Title**	**Schedule**	**Action Required**
		Final presentation due at review Action item response plan due 1 week after review	
PM-11	Instrument Critical Design Review (ICDR) Package	Draft presentation due 1 week prior to review Full data package due 1 week prior to review Final presentation due at review Action item response plan due 1 week after review	R
PM-12	Instrument Test Readiness Review (TRR)	As required	R
PM-13	Instrument Pre-Environmental Review (IPER) Package	Draft presentation due 1 week prior to review Full data package due 1 week prior to review Final presentation due at review Action item response plan due 1 week after review	R
PM-14	Instrument Pre-Ship Review (IPSR) Package	Draft presentation due 1 week prior to review Full data package due 1 week prior to review Final presentation due at review Action item response plan due 1 week after review	R
PM-15	Inputs to Mission Milestone Reviews	30 days before each mission milestone review	R
PM-16	EVM Reporting	Due 10th working day of each month, starting 4 months prior to IPDR for the demonstration period and 1 month after IPDR for official EVM reporting	R
PM-17	Input for Project Joint Confidence Level Analysis	Needed in preparation for KDP-C	R
PM-18	Input for Instrument Integrated Baseline Review	90 days after KDP-C	R
PM-19	Work Breakdown Structure and Dictionary	Kickoff Meeting	A

PROJECT MANAGEMENT			
ID	**Title**	**Schedule**	**Action Required**
PM-20	Technology Development Plan	Due 60 days after contract award	R
PM-21	IT Security Plan	Due 60 days before ISRR	A
PM-22	Photographs and Video	No later than instrument delivery	I
PM-23	ECPs, Deviations and Waivers	Class I, as generated Class II, as requested	A I

SYSTEMS ENGINEERING			
ID	**Title**	**Schedule**	**Action Required**
SE-1	Instrument STOP Analysis Package (if applicable)	Preliminary: IPDR Final: ICDR Update as required	A
SE-2	Structural Models: - Detailed for Instrument FEA - Simplified Model FEA	Draft: ISRR Preliminary: IPDR Final: ICDR Update as required	A
SE-3	Thermal Model	Draft: ISRR Preliminary: IPDR Final: ICDR Update as required	A
SE-4	Instrument Requirements Document	Preliminary: ISRR Final: IPDR	A
SE-5	FPGA Development Plan	Preliminary: IPDR Final: ICDR Update as required	A
SE-6	FPGA Data Design Package	Preliminary: ICDR Final: IPDR Update as required	A
SE-7	Calibration Data Records	30 days post instrument-level calibration testing	R
SE-8	Input to Interface Control Documentation	Preliminary: IPDR Detailed: ICDR Updates as required	R
SE-9	Input to Gold Rule Compliance Matrix	6 months prior to IPDR	R
SE-10	CAD Models	Draft: ISRR Preliminary: IPDR Final: ICDR Update: IPSR	I

SYSTEMS ENGINEERING			
ID	**Title**	**Schedule**	**Action Required**
SE-11	Coordinate Systems Document	Preliminary: 2 weeks prior to at ISRR Update: 2 weeks prior to IPDR & ICDR Final: 2 weeks prior to IPSR	A
SE-12	Instrument Development Plan	Preliminary: ISRR Final: IPDR	A
SE-13	Digital Electronics Signal Integrity and Power Integrity Analysis	2 months prior to 1st instrument flight build	A
SE-14	Risk Management Plan	Preliminary: 2 months after instrument selection Final: ISRR Update as required	A
SE-15	Verification and Validation Plan	Draft: ISRR Preliminary: IPDR Final: ICDR	A
SE-16	Observatory Level Test, Verification, and Calibration Reports	Preliminary Two weeks following test Final: One month following test	A
SE-17	Input to Project Systems Engineering Management Plan	Preliminary: 2 months after instrument selection Final: ISRR Update as required	R
SE-18	Engineering Drawings, Trees and Lists	Preliminary: at peer reviews and TIMs Final: At Instrument Delivery	I
SE-19	Analyses	Preliminary: 10 days before IPDR Revision: 10 days before ICDR Final: 10 days before IPSR Revision: as generated	I

FLIGHT SOFTWARE			
ID	**Title**	**Schedule**	**Action Required**
SW-1	Software Development Plan	Preliminary: ISRR Final: IPDR Update as required	A
SW-2	Software Requirements Specification	Draft: ISRR Preliminary: IPDR Final: ICDR Update as required	A
SW-4	Software User's Manual (SwUM) Software Design Description Documentation	Preliminary: ICDR Final: IPSR Update as required	A
SW-5	Flight Software Delivery Package	Preliminary: ICDR Final: IPSR Update as required	R

INTEGRATION AND TEST			
ID	**Title**	**Schedule**	**Action Required**
IT-1	Instrument Level Integration & Test Plan	Preliminary: ICDR Final: 30 days prior to I&T start	A
IT-2	Packing, Handling, Storage & Transportation Plan	30 days prior to IPSR	A
IT-3	Calibration Plan	Draft: ISRR Preliminary: IPDR Final: ICDR	R
IT-4	Observatory Level Instrument Test Procedures	Preliminary: 30 days before use Final: 5 days before use Update as required	A
IT-5	Command & Telemetry Data Formats	Draft: ICDR Final: 2 months prior to delivery	A
IT-6	Support Equipment End Item Data Packages	10 days prior to delivery of item	A
IT-7	Instrument Constraint Document	Draft: ICDR Final: IPSR	A

MISSION OPERATIONS			
ID	**Title**	**Schedule**	**Action Required**
OPS-1	Command and Telemetry Handbook	Draft: ICDR plus 6 months Final: 60 days prior to	A
OPS-2	Operation and Maintenance Manual	Draft delivered 1 month prior to IPER Final delivered at IPSR	A
OPS-3	Inputs to Mission Operations Plan	Draft: ORR Final: FRR	A
OPS-4	Inputs to Mission Concept of Operations	Draft IPDR Final: ICDR	A

Science Investigation			
ID	**Title**	**Schedule**	**Action Required**
SI-1	Input to Science Data Management Plan	As Required	A
SI-2	Inputs to Mission Archive Plan	Preliminary: IPDR Final: ICDR	A
SI-3	Levels 1-4 Data Requirements	Preliminary: IPDR – 4 months Final: ICDR	A
SI-4	Algorithms and Verified Code Input to the SOC for Pipeline	SOC Software Build 1 to support Softsim SOC Software Build 2 to support Flatsat SOC Software Build 3 to support I&T SOC Software Build 4 to support mission operations pre-launch	A
SI-5	Inputs to GDC Science Data Product User's Guide	Preliminary: ICDR Final: PER	A
SI-6	Instrument Design and Operations Article	Preliminary: PLAR Final: PLAR+3 months	R
SI-7	Scientific Publications	As appropriate	I
SI-8	Inputs to Extended Mission Proposal	Preliminary: one year before Senior Review Final: three months before Senior Review	A
SI-9	Science Working Group Report	Biweekly	I
SI-10	Science Team Meeting Reports	3x per year, 2-3 days	I
SI-11	Phase E Science Planning Telecons	In Phase E, weekly science planning telecons	I

MISSION ASSURANCE

Descriptions of Mission Assurance DIDs can be obtained in the GDC Instrument Mission Assurance Requirements (IMAR)

3.0 PROJECT MANAGEMENT

PM-1 Configuration Management Plan

Description:

The CM plan describes the methods and procedures used to manage the functional and physical characteristics of configuration items, and their interfaces and identification documents, during definition, design, fabrication, assembly, and testing.

Content:

1. The plan shall describe the contractor's configuration management organization and personnel responsibilities.
2. The plan shall describe the contractor's configuration identification system, including drawing and specification standards.
3. The plan shall accommodate the requirements of the contract relative to technical direction and approvals.
4. The plan shall describe the contractor's change control system and shall include sample change documents and/or forms.
5. The plan shall define the interfaces between the contractor's change control system and GSFC CM Office.
6. The plan shall describe which types of changes will be submitted to GSFC for approval, and the process for their submittal.
7. The plan shall define the contractor's engineering data management activities (including archiving process), documentation approvals, release procedures, and categories of release.
8. The plan shall describe the contractor's configuration status accounting system including samples of lists and reports used.
9. The plan shall describe the contractor's approach to verification and configuration audit to ensure that performance and functional requirements have been achieved by the design.
10. The plan shall describe contractor’s approach for using photographs as part of the Configuration Management/documentation process.

PM-2 Detailed Schedule (Inputs to IMS)

Description:

The instrument schedules shall be provided for planning, statusing, controlling, modeling and specifying work activities throughout the project life cycle.

Content:

Detailed network diagrams shall be developed, delivered, and maintained for each subsystem. These subsystem networks may be provided separately, or combined into an Integrated Master Schedule (IMS). These networks shall reflect the significant activities in sufficient detail to permit adequate visibility into work progress including all of the activities necessary to meet the requirements of the Statement of Work, the detail activities of lower-tier developers, all CDRL documentation deliveries, information on each software milestone, and clearly identified schedule margin. The network diagrams shall also include all logical relationships (interdependencies) between tasks. Schedules shall contain the approved baseline as well as current forecasted dates and shall be traceable to the approved Work Breakdown Structure (WBS). All key milestones shall be clearly identified including: contract milestones, design reviews, readiness reviews, descope decision points and major receivables/deliverables among subsystems/organizations (including subcontractor effort). Milestones shall be logically linked to related tasks. Clearly identified schedule margin tasks and dates needed for Government Furnished Property (GFP) shall be included in the network. A log of changes to the schedule baseline will be maintained and reported monthly.

Monthly updates shall reflect progress the Instrument Provider has made toward accomplishing scheduled activities, and any projected changes to the start and completion dates of scheduled activities. Monthly updates shall also reflect progress on any weighted milestone and any projected changes to completion dates of Weighted Milestones.

Scheduling Tool/Process: The contractor shall use an application that is compatible with Microsoft Project. The tool shall support data transfer and integration into Microsoft Project.

The following status and analysis reports shall be provided monthly:

1. Detailed Schedule: The complete networked schedule with status as of the latest end of month.
2. Top-Level Contractor Summary Schedule: Top-level schedule (chart), in GDC project compatible software, suitable for a formal presentation.
3. Critical Milestone Chart: The contractor will also prepare a Critical Milestone Chart showing the most significant activities over the period [(current date – 3 months) to (current date + 9 months)]. This chart should clearly show the schedule critical path as well as identifying any milestones that have changed along with the explanation for the change.
4. Manufacturing Schedules: Manufacturing schedules and status obtained from subcontractors and vendors are not required to be submitted with the monthly schedule submittal, however, they shall be supplied to the Project Office upon request with their

component status reflected in the appropriate section or subsystem in the intermediate schedule.

PM-3 Monthly Contractor Financial Management Reports (533M)

Description:

The Monthly Contractor Financial Management Reports (533M) provide contractual expenditure data of cost incurred during the month being reported, summaries of cumulative costs, and estimates of costs to complete. This information is necessary for the financial management of this contract.

Content:

Financial Management Reports shall be submitted by the contractor on the NASA 533 series reports, in accordance with the instructions on the reverse of the forms, NPR 9501.2E entitled "NASA Contractor Financial Management Reporting" dated May 2011, and additional instructions issued by the GSFC Contracting Officer.

The contractor's 533 reports shall be provided at the contract summary level during all contract phases and also at the third WBS Levels during Phases B/C/D. The Contracting Officer may direct the Contractor to provide 533 reports at lower WBS levels for select WBS elements.

The contractor shall distribute 533 reports by posting to the GDC Management Information System (MIS) not later than the tenth (10th) working day following the close of the contractor's monthly accounting period.

PM-4 Quarterly Contractor Financial Management Reports (533Q)

Description:

The Quarterly Contractor Financial Management Reports (533Q) provide contractual expenditure data of cost incurred and estimates of costs to complete. The 533Q reports provide a more detailed estimate of costs for the coming months and quarters than is contained in the 533M reports.

Content:

Financial Management Reports shall be submitted by the Contractor on the NASA 533 series reports, in accordance with the instructions on the reverse of the forms, NASA Procedural Requirements NPR 9501.2E entitled "NASA Contractor Financial Management Reporting," and additional instructions issued by the GSFC Contracting Officer. Instructions for level of detail, distribution, and contents (reporting categories) are the same as for Monthly Financial Management Reports (533M); see PM-3.

533Q reports delivered in March, June, and December shall update planned costs for months in the following quarter in Columns 8a, 8b, and 8c. The 533Q report delivered in September shall update planned costs for months in the following government fiscal year, replacing Columns 8d, 8e, 8f, and 8g with columns to show a month-by-month forecast for the next twelve months beginning with October. The 533Q report delivered in September shall also include a workforce plan for the next government fiscal year, presenting planned workforce (full-time equivalents) by month at the same WBS levels at which 533 reports are required.

PM-5 Instrument Monthly Report (IMR)

Description:

The instrument monthly status reports shall provide a project assessment of contract technical accomplishments, summary of program cost, schedule, and performance, as well as the status of key technical issues and near-term milestones. These reports shall provide a summary of the activities for the month, highlight issues/problems/concerns, and briefly summarize plans for the following month. Detailed supporting technical data should only be provided on an as requested basis.

The Contractor shall summarize schedule status on charts following an agreed upon format. In addition, any changes to the baseline schedule needs to be highlighted on these charts in a manner that shows the original baseline and the new modified baseline, with an explanation for the change.

Content:

Providers should include:

1. Schedule Status and variance from baseline
2. Technical Status
3. Risk Summary and Mitigation Status
4. Safety and Mission Assurance Status
5. Cost Summary and Contingency Release Status including Lien List (Cost, Schedule etc)
6. Action Item Status
7. Two Month Look-ahead
8. Technical Performance Margins
9. Issues and concerns
10. One page fever chart summarizing critical status of above elements

PM-6 Input to GDC Monthly Status Report (MSR)

Description:

The input to the instrument portion of the GDC MSR is a short executive summary based on each IMR (PM-5) submittal for use by the project in assembly of the payload portion of the MSR. The contractor shall provide these summary charts as part of the monthly PM-5 deliverable.

Content:

Executive summary chart of technical and schedule status; issue/concerns chart; risk summary chart; cost performance summary chart; action item status

PM-7 Instrument Weekly Status Report

Description:

The Instrument Weekly Status Report is provided for review and possible incorporation into the GDC project weekly report.

Content:

Typically, 3-5 bullets are provided covering instrument technical and programmatic status over the course of the week. Accomplishments, risks, issues, status, and near-term plans may be covered.

PM-8 Instrument Peer Reviews

Description:

Instrument providers shall conduct appropriate technical peer reviews for lower-level components and prior to milestone reviews to validate their approach and design decisions.

GSFC will attend select peer reviews via telecon, but may request in-person attendance for critical peer reviews. Project Office participation should in no way alter planned in-depth table-top discussions (no need to create additional presentation materials). Action items shall be recorded, and minutes written for each peer review.

Peer reviews that are required or strongly recommended include, but are not limited to:

a) Peer reviews prior to milestone reviews (Required)

b) Design reviews of complex parts such as ASICs, FPGAs, and Hybrids. (Required)

c) Peer Reviews of designs, documents, processes, and software.

d) Reviews with subcontractor developers

e) Inheritance reviews for hardware and software

f) Hardware, software and support equipment delivery reviews

Below are peer level reviews that may be applicable to the instruments:

1. Subsystem Peer Reviews
    a. Flight Hardware
    b. Flight Software
    c. GSE
    d. I&T (including calibration)
2. Board-Level Peer Reviews
    a. Board-Level Electrical Design Review
    b. FPGA Review
    c. Fabrication Feasibility Review

Content:

Providers should include:

- A (preliminary and baseline) comprehensive list of planned reviews including the (1) Title, (2) Objective of review if not apparent from the title, (3) Organization responsible for conducting the review, (4) Estimated date, and (5) Location.

As requested by the project, Providers should include:

1. A brief, draft agenda in accordance with the objectives prior to each review.
2. Prior to each Project review, prepare and submit a review package, presentation material and the supporting data necessary for the complete understanding and assessment of the review.
3. The report for each review, for which the Instrument Provider is the chair, shall include the following: (1) List of attendees, (2) Findings or minutes, (3) Copies of Requests for Action (RFAs).
4. Summary List of Action Items, including person(s) responsible for closure, due date, status, closure date and closure summary, and reference to closure documentation.

PM-9 Instrument System Requirements Review (ISRR)

Description:

The purpose of this review is to verify that the functional and performance requirements are defined for the system under review and to ensure the requirements are satisfied by the selected concept. To justify proceeding with detailed definition and the flow-down of requirements to the major elements of the system, the instrument team/project must convey to the review panel that the:

1. Baseline mission requirements and driving instrument requirements are clearly understood
2. Draft instrument requirements have been determined
3. Proposed instrument design and operations concept satisfies baseline mission requirements
4. Plans for future activities justify expectations the instrument design will accommodate imposed constraints and accomplish the mission within allocated resources

Content:

The full review package content shall contain all data required to satisfy the objectives, success criteria, evaluation factors, and desired results for an instrument level ISRR as defined in Appendix B-2 of GSFC-STD-1001A, "Criteria for Flight and Flight Support Systems Lifecycle Reviews" dated October 1, 2009. In addition, the ISRR package shall identify a list of all long lead parts, identified as flight parts and materials that must be procured in Phase B.

The final presentation shall be a viewgraph summary of the full review package content.

PM-10 Instrument Preliminary Design Review (IPDR) Package

Description:

At the IPDR, the instrument team/project discloses the complete system or subsystem requirements and design to the review panel. The ability of the preliminary design to meet all requirements within acceptable risk is presented. The projections for completing the instrument within the identified cost and schedule constraints are also provided. The readiness to proceed with the detailed design is demonstrated by:

1. Completing a credible and acceptable preliminary design that meets performance requirements
2. Selecting a suitable design solution, making necessary resource allocations, and identifying critical interfaces and requirements verification methods
3. Confirming requirements compliance with supporting design analyses
4. Presenting acceptable plans for the completion of system or subsystem development and the subsequent operations (if applicable) within the identified cost and schedule constraints

Content:

The full review package content shall contain all data required to satisfy the objectives, success criteria, evaluation factors, and desired results for an instrument level IPDR as defined in Appendix C-2 of GSFC-STD-1001A, "Criteria for Flight and Flight Support Systems Lifecycle Reviews" dated October 1, 2009.

The final presentation shall be a viewgraph summary of the full review package content.

PM-11 Instrument Critical Design Review (ICDR) Package

Description:

The ICDR evaluates the completeness of required design analysis, test, and establishment of design margins. The Instrument Team/project discloses the complete system design to the review panel to show that it meets requirements. The Instrument Team/project demonstrates that the maturity of the design and development effort:

1. Justifies proceeding with full scale fabrication activities, assembly, integration and test
2. Is on track to complete flight system, ground system, and mission operations development
3. Meets instrument performance requirements within the identified cost and schedule constraints

Content:

The full review package content shall contain all data required to satisfy the objectives, success criteria, evaluation factors, and desired results for an instrument level CDR as defined in Appendix D-2 of GSFC-STD-1001A, "Criteria for Flight and Flight Support Systems Lifecycle Reviews" dated October 1, 2009.

The final presentation shall be a viewgraph summary of the full review package content.

PM-12 Instrument Test Readiness Review (TRR)

Description:

TRRs evaluate the readiness of flight hardware items to be tested. This type of review is held at any level of hardware integration, prior to system I&T delivery, when the testing would place the flight hardware items at risk, are of high importance or have increased complexity, e.g., prior to environmental qualification and/or flight acceptance testing. This type of review is held to demonstrate the readiness to proceed with instrument environmental testing.

Content:

TRRs review:

1. Environmental test plans
2. Ambient test results
3. Status of open anomaly reports
4. Closure of other open engineering issues
5. Calibration plan and procedures
6. The readiness of personnel, test procedures, test equipment, and test facilities is assessed.

PM-13 Instrument Pre-Environmental Review (IPER) Package

Description:

The IPER evaluates the instrument's readiness to proceed with environmental testing as an integrated system. The IPER is held after successful completion of the initial comprehensive performance test of the fully-integrated flight instrument and prior to initiation of the instrument-level environmental test sequence.

At the IPER, the Instrument Team/project discloses their complete instrument status to the review panel. The Instrument Team/project demonstrates that the flight system is:

1. Ready to proceed with environmental testing as an integrated system
2. On track to complete development and conduct operations, if required, within allocated cost and schedule resources

Content:

The full review package content shall contain all data required to satisfy the objectives, success criteria, evaluation factors, and desired results for an instrument level IPER as defined in Appendix G-2 of GSFC-STD-1001A, "Criteria for Flight and Flight Support Systems Lifecycle Reviews" dated October 1, 2009.

The final presentation shall be a viewgraph summary of the full review package content.

PM-14 Instrument Pre-Ship Review (IPSR) Package

Description:

The IPSR evaluates the readiness of hardware, software, or support equipment for delivery to system assembly, integration, and test and includes the EM, FM, spares and GSE

The IPSR is the final review of hardware and software documentation, analysis, compliance, and open item closeout process prior to delivering hardware for integration.

At the IPSR the instrument demonstrates to the review panel that:

1. All instrument verification activities have been successfully completed and the system meets its requirements
2. The system and support (flight and ground) hardware, software, personnel, procedures, and user documentation accurately reflect the final operational state of the instrument under review
3. The system is ready for shipment and/or final processing prior to integration
4. The completeness of the End Item Acceptance Data Package (EIADP), waivers, open failure reports, and closed but unverified failure reports
5. The pre-delivery problem/failure reports have been properly closured and/or risk assessments have been performed and documented.

Content:

The full review package content shall contain all data required to satisfy the objectives, success criteria, evaluation factors, and desired results for an instrument level IPSR as defined in Appendix I-2 of GSFC-STD-1001A, "Criteria for Flight and Flight Support Systems Lifecycle Reviews" dated October 1, 2009.

The final presentation shall be a viewgraph summary of the full review package content.

PM-15 Inputs to Mission Milestone Reviews

Description:

The instrument provides a summary of their milestone review content for presentation at the subsequent mission milestone review. These reviews include the mission SRR/MDR, PDR, CDR, PER, and PSR.

Additional content will be required by the project as needed for the Mission SIR, MOR and ORR.

Content:

In most cases, the inputs for the mission review will be summarized from the preceding instrument review presentation and results. Changes will be negotiated with the GDC project.

PM-16 EVM Reporting

Description:

The instrument shall provide cost and schedule data to the GDC Project who will then incorporate the data into the overall EVM performance report. The GDC Project will

provide the instrument EVM data/report for the instrument to provide a Variance Analysis Report addressing schedule, cost and variance at complete out of tolerance values.

The cost profile and schedule artifacts are to be provided 3 months following contract award. The artifacts will be reviewed jointly with the intent to establish the integrated baseline 4 months prior to PDR. Leading up to PDR, performance metrics will be established and reported to be included as part of the programmatics of the review. EVM reporting will continue through commissioning.

Content:

A Performance Measurement Baseline (PMB) shall consist of a baseline spend plan/profile along with a baselined Integrated Master Schedule (IMS) (see PM-2). The PMB shall be reviewed for reasonableness and jointly concurred with the instrument provider and the GDC Project. Any changes to that PMB are to be coordinated and communicated for approval by the GDC project. Schedule status and cost data shall be organized and reported to the instrument level 3 WBS (or as appropriate subject to agreement). Typically, the reporting level is defined as control account (CA) level. All elements of instrument work shall aggregate from the CAs, including work for the instrument done by subcontractors or government institutions.

During the period of review the IMS will be used to establish the integration of scope, schedule and budget (resources) necessary to accomplish the work scope contracted. The IMS through the use of activities or milestones will be used define and measure accomplishment based on the budgeted profile or cost plan (for example via weighted tasks). Values for all or a selection of those objects will be used to assess the performance of the PMB.

Monthly EVM reporting provided to the GDC Project include the IMS with an assessment of task % complete status. Actual costs for the month are to be recorded and reported at the Control Account level. Actual costs shall include estimated actuals, which are estimated costs for work performed (including procured materials received) but for which no payment has been recorded in the instrument accounting/financial system. This includes work performed by subcontractors for which no invoice has been received or payment recorded. Estimated Actuals are to be provided in the monthly reports by the control accounts the costs are to be applied to. The providing of estimated actuals is necessary to ensure the “Actual Cost of Work Performed” (ACWP) is reported commensurate to the accomplishment claimed.

A Variance Analysis Report (VAR) is to be provided at the level above the Control account that exceeds a to be agreed to cost and schedule breech value for the following: current month, cum to date for both schedule, and cost and an at complete variance for cost. The variance report will explain the root cause of the variance including any connection to identified risks, the impact to the element and the impact to the overall plan, along with a

corrective action (plan). The corrective action plan will include statusing of those actions through completion.

Monthly, along with the performance data and VAR, the instrument provider is to provide notification of changes to the PMB as represented in the IMS. Updates include but are not limited to: updates to task weighting (value), updates to the baseline spend plan. These revisions shall include rationale and reasons for the change. The changes, based on the impact both internal or external to the instrument, will be subject to review and acceptance by the GDC Project.

In addition to the baseline performance artifacts the instrument provider shall provide an updated forecast (or estimate to complete) represented in the IMS for favorable and or unfavorable execution of the baseline plan as well as any favorable or unfavorable costs related to work to be performed in the future. The frequency of updates to the estimate to complete for cost shall be in accordance with the organizations update policy but shall be done at least quarterly. The estimate at complete shall be provided at the control account level and summarized at the top level of the WBS. Deviations of the Estimate at Complete (EAC) are to be used as the basis in the VAR for the at complete variance analysis.

PM-17 Input for Project Joint Confidence Level Analysis

Description:

The contractor shall provide data to be used as input into the Project Joint Confidence Level analysis in preparation for KDP-C.

Content:

The contractor shall provide the same schedule used in the management of their instrument development to the Project for use in their Joint Confidence Level analysis.

The contractor will support the project in performing the various activities associated with the analysis, which may include:

1. Review built schedule
    a. Logically linked network
    b. Minimize use of constraints
    c. Provides arcs to major milestones of the analysis
    d. Cognizant of cost and risk application
    e. Run Schedule Health check to analyze viability for analysis
2. Cost load schedule

a. Separate costs into Time Dependent and Time Independent
b. Map costs to schedule
c. Load costs as resources into schedule

3. Implement risk list
    a. Quantify likelihood and impacts (cost and schedule)
    b. Identify links to schedule activities
    c. Derive probabilistic stats
    d. Load risks into the IMS (multiple options)
4. Conduct uncertainty analysis
    a. Schedule uncertainty (multiple options)
    b. Identify method for assessment (consistency is key)
    c. Incorporate correlation
    d. Cost uncertainty- how much can resources vary
5. View results
    a. Critical path
    b. Drivers
6. Analyze results
    a. Review risks and refine results

PM-18 Input for Integrated Baseline Review

Description:

An Integrated Baseline Review (IBR) is an assessment conducted to verify the realism and accuracy of the Performance Measurement Baseline (PMB). This involves verifying the technical content of the baseline and assessing the realism and accuracy of the related resources (cost, risk, and schedule). The Integrated Baseline Review is the major EVM review for the contract. The IBR package is a compilation of on-going operational project documents gathered together for the purpose of assessing the PMB.

The GDC Project will conduct an Instrument IBR to review and approve the instrument EVM processes and PMB. This will support the subsequent GDC Project IBR.

Content:

An IBR Data Package shall be submitted in accordance with the IBR objectives stated above.

The Contractor Data Package shall contain the following:

1. Program/Business Management and Control Account data products requested by the Project Office
2. A baseline electronic version of the Integrated Master Schedule in native format
3. Contractor Earned Value process description
4. Two months of EV Performance data

The contractor shall ensure proper flow down of this requirement to subcontractors. The data package shall be delivered not less than two weeks prior to the IBR.

PM-19 Work Breakdown Structure and Dictionary

Description:

The Work Breakdown Structure (WBS) and Dictionary establishes the basic framework within which all effort necessary to meet the requirements of this Contract is identified and defined. It provides the logical structure for planning and controlling costs.

Content:

Provide an instrument Work Breakdown Structure (WBS) that provides a logical framework for organizing project budgets and schedules and maps into the Project WBS.

The lowest level of the WBS shall correspond to at least the lowest level at which work is scheduled, work is accomplished, and actual costs can be compared. The level of detail shall be defined during Contract negotiations. The WBS shall be coded to establish the relationship among all of its levels. The WBS coding shall be used to identify each particular WBS Item on all program budgets, schedules, and financial reports. The WBS shall indicate which Items require monthly financial reporting.

The WBS Dictionary shall be prepared to define each Item of the WBS. These definitions shall describe the work to be performed, the criteria for completing the work, the organization responsible for the work and the major deliverable (s) involved (if applicable).

After the initial Project approval, the WBS and Dictionary shall be modified only with the prior consent of the GDC Project.

PM-20 Technology Development Plan

Description:

This plan identifies technologies that are planned as part of the instrument's design but are not yet at a Technology Readiness Level (TRL) of 6, and explains the development approach

to achieve TRL 6 by PDR. See NPR 7123.1C, NASA Systems Engineering Processes and Requirements, for an explanation of the TRL levels.

Content:

1. List the technologies that are planned as part of the instrument's design but are not yet at TRL 6.
2. For each technology:
    a. Describe the instrument's usage and rationale for the technology, including the associated requirements.
    b. Describe and substantiate the current maturity level.
    c. Describe the challenges associated with the technology.
    d. Describe fall-back alternatives and options, if necessary, and the impacts of using them.
    e. Describe the test and analysis plans to achieve TRL 6.
    f. Describe the fidelity of the test articles and of the test environment. Highlight where there are departures from expected flight conditions, why the departures are necessary, how analysis is used to close the gap, and any resultant uncertainties in the results (relative to flight).
    g. Describe test facilities and equipment planned for use and any restrictions on their use. Include test facility upgrades or other development.
    h. Describe how the technology will be transitioned from Phase B to flight production, including procurement/manufacturing plans and interim items such as engineering or qualification articles.
    i. Provide a timeline of major activities and decision points.

PM-21 IT Security Plan

Description:

Document the project's approach to implementing IT security requirements in accordance with NPR 2810.1A, Security of Information Technology.

Content:

When describing how NPR 2810.1A requirements will be met in the IT Security Plan, place special emphasis on describing how the project will meet the following requirements:

1. Conduct the Information/System Security Categorization for IT systems during Phase A of the project.

2. Perform the IT system risk assessment during Phase B of the project.
3. Document and implement all technical, management, and operational security controls for IT systems during Phase D of the project.
4. Meet the IT security certification and accreditation requirements for IT systems during Phase D of the project.
5. Conduct an annual IT security assessment of IT systems during Phase E of the project.

PM-22 Photographs and Video

Description:

Documents and provides a video history and real-time capture of the instrument build and I&T.

Content:

The contractor shall include the following photo and video records in the End Iten Acceptance Data Package. These records are as follows:

1. Still photography serves as a record of the build-up of a major component or subsystem; e.g., a typical electronic card, mother board, electronic subsystem with cover off, etc.

a. Pictures taken at appropriate points in the development of the instrument.

b. Pictures taken of the major subsystems, critical components, the full-up system, and major GSE items; taken in color and provided in a digital format on appropriate medium

c. Pictures taken of the major subsystems, critical components, the full-up system, and major GSE items; taken in color and provided in a digital format on appropriate medium

d. Pictures of environmental test fixtures.

e. Full views of the completed instrument.

f. Pictures taken of the major subsystems, critical components, the full-up system, and major GSE items; taken in color and provided in a digital format on appropriate medium

2. Video record the assembly of the instrument in sufficient detail to be used for training and, if needed, failure investigation, including all lifts and mechanism deployments (as applicable).

PM-23 ECPs, Deviations and Waivers

Description:

To coordinate and control all Deviations, Waivers and ECPs

Content:

Before instrument delivery the contractor shall submit any class I Engineering Change Proposal (ECP) and the associated waiver or deviation to the Government for approval.

After instrument delivery the contractor shall submit all ECPs and their associated waivers or deviations to the Government for approval.

Engineering change proposals (ECPs) document changes to the Contractor's standard instrument design, using EIA-649-B (Configuration Management Standard), ECP forms DG 1692 and DD1692-1 as guidelines. The ECP contains sufficient information in the form of attachments, drawings, test results, etc., to allow the Government to evaluate the total impact of the proposed change.

A class I ECP is a change that:

1. Affects any Government contract specification or interface requirement.
2. Affects schedules of end item deliverables to the Government.
3. Impacts Government furnished equipment/property.

Waivers and deviations are handled using EIA-649-B as a guide.

NOTE: Risk trade-off evaluations based on Probabilistic Risk Assessments (PRA) or other applicable analysis techniques may be required as part of the documentation for a variance, deviation, or waiver at the discretion of the GDC Project management.

4.0 SYSTEMS ENGINEERING

SE-1 Instrument STOP Analysis Package (if applicable)

Description:

Structural, Thermal, and OPtical (STOP) analysis is performed to obtain a very accurate prediction of the optical performance of the instrument. First a thermal model is developed to predict the local temperatures of the optical system at all the various locations of interest. The thermal model's temperature predictions and their locations are then mapped to a finite element structural model (typically use NASTRAN) where the mechanical motions and deformations caused by the temperature gradients (both in time and space) are calculated. The finite element model motions are then input into an optical ray trace model where rays are traced to predict optical performance (Code V or Zemax could be used). Sometimes a linear approximation approach can be performed instead of doing full up ray tracing. To do that the optical models are used to generate optical sensitivities as a function of mechanical motion and generate large matrices of sensitivity coefficients. Then the mechanical motions are multiplied by the sensitivity coefficients to predict optical performance.

Content:

Requires the designation of an integrated modeling lead (typically the finite element modeling lead, optics lead or systems engineer). Then definition of the nodes in the finite element and optical model to be tracked, followed by a node validation process to make sure the mechanical and optical models are talking about the same point or piece of hardware. Establish the particular environmental cases to be modeled and if the models will be used to predict absolute performance values or just the variability in the performance induced by the environment.

Deliverable shall consist of summary reports and analysis integrating the above three disciplines showing methodology, tools, requirements including applicable environments, and system performance. The assembled data package shall be delivered 14 days prior to Instrument Systems Reviews (IPDR, ICDR) to the Project Office.

SE-2 Structural Models

Description:

To provide test verified mathematical models that represent the static and dynamic structural characteristics of the instrument that can be utilized with other data to predict structural accelerations, deflections, and internal loads for elements which have fundamental frequencies below 100 Hz.

Content:

The contractor shall develop and document test-verified mathematical structural models in the launch configuration. These shall include a structural finite element model and a dynamic model in Craig-Bampton form, developed, verified, and documented as described below. The finite element model shall represent the structural and dynamic characteristics of the instrument. Interface degrees of freedom shall be compatible with corresponding attachment degrees of freedom on the model of the spacecraft. The dynamics model shall be based on the finite element structural model using standard reduction techniques such as Craig-Bampton reduction.

The test verified structural finite element models and dynamic models shall be provided on electronic medium in a format acceptable to the spacecraft contractor for the performance of the verification loads cycle analysis.

The dynamic models shall:

1. Be in Craig-Bampton form with modes that represent the dynamic characteristics of the instrument to at least 100 Hz,
2. Define dynamic degrees of freedom to allow calculation of acceleration levels and relative deflections at critical points, and
3. Include Load Transformation Matrices (LTM) described in the next section.

The finite element model documentation shall include the following:

1. A listing of the input data for the model,
2. Model definition plots, coordinate system definition, mass properties, and any other pertinent model definition information, along with documentation of the correlation between the modeled properties and the instrument design,
3. Mode shapes, frequencies, modal damping, modal participation factors, modal effective weights, correlation between analytical and test modes, and all data required to demonstrate test-verification of the models
4. Characterization of all significant frequencies and mode shapes for the component constrained at the launch vehicle boundary points.

B. Load Transformation Matrices (LTM's)

The Load Transformation Matrices shall be fully documented and provided on electronic medium in a format acceptable to the spacecraft and/or launch vehicle contractor. The LTMs shall:

1. Consist of influence coefficients relating selected output variables to the associated dynamics model response variable,
2. Include spacecraft and/or launch vehicle interface reaction forces, component/ interface reaction forces, and reaction force at support locations for deployables,
3. Include force, shear, and moment coefficients for determining internal loads in critical structural members, and
4. Include coefficients for determining absolute and relative deflections of component internal elements.

The LTM documentation shall provide:

1. A description of the model(s) from which the LTMs were generated,
2. A description of each row of the LTM,
3. Instructions for use of the LTM, including discussion of the equations used for computing internal transient loads, and
4. Results of standard checks performed for verification of the LTM (e.g., response to 1g accelerations and unit displacements at the interface).

STRUCTURAL MODEL VERIFICATION PLAN

In support of the development of the test-verified structural models, the contractor shall develop a verification plan which includes:

1. Identification of the modeling techniques and analysis programs to be utilized,
2. Analytical and testing techniques to be used to verify the analytical models and, where required, plans for revising models and repeating analyses based on verification results,
3. A description of analyses to be performed, along with the objective, scope, and output of each analyses, and description of testing which will be used for model verification, and,
4. A compilation of required loads interface data (e.g., loads to components or deployables, or loads from launch vehicle(s), etc.), and a schedule of need dates.

All models, simulations, and/or databases required by this ID shall be electronically delivered on software compatible with the hardware platform on which it is to execute. All models, simulations, and/or databases must include everything necessary to provide a fully functioning computer model whose execution requires only commercially available hardware and software.

Consultation between the Investigator team, the Project Office, and spacecraft vendor will define deliverable complexity. Report of FEA model analysis and behavior will be available as part of the IPDR and ICDR review package, and a simplified operational FEA model will be required to be delivered to the spacecraft vendor. An Electronic copy of the FEA Model will be archived at the Investigator's facilities and will be available for inspection.

SE-3 Thermal Models

Description:

The instrument thermal model is a mathematical representation of the heat transfer between the spacecraft, the instrument and the environment and is used to evaluate the thermal performance of the instrument. This model shall accurately predict the heat flows and the resulting temperature changes for any alteration in the environment, internal power dissipation, or any other thermal model parameter.

Content:

The mathematical representation shall consist of a Geometric Model (GM), with which radiation couplings and environmental heat fluxes are calculated, and a Temperature Model (TM), which calculates the heat transfer and resultant temperatures. Each model shall have sufficient detail of all subsystems and critical interfaces to accurately predict temperatures. These models shall be verified and refined after comparison with thermal test data.

A list of all nodes with nodal descriptions shall be provided. Sketches showing how nodes correspond to hardware components shall be included. Describe each node of the TM, its correspondence to a surface or surfaces of the GM, and discuss the nodalization rationale and how accurately the nodalization thermally represents the actual hardware.

All models, simulations, and/or databases required by this ID shall be electronically delivered on software compatible with the hardware platform on which it is to execute. All models, simulations, and/or databases must include everything necessary to provide a fully functioning computer model whose execution requires only commercially available hardware and software.

Consultation between the Investigator team, the Project Office, and the spacecraft vendor will define deliverable complexity. The initial baseline for the thermal math model node count should be consistent with previous missions (10 to 100 nodes per unit).

SE-4 Instrument Requirements Document

Description:

This deliverable contains the functional and performance requirements allocated to each instrument component within the instrument (element or suite). These requirements either trace back to the MRD or have specific rationale for their incorporation.

Content:

Requirements documentation will include

1. A shall statement that states the actual requirement
2. A description if needed to provide context and clarification
3. Rationale statement. If traceable to MRD, rationale should include what requirement it was inherited or derived from
4. Abbreviated verification approach

Include the following requirement categories:

a. Measurement
b. Operational
c. Command and telemetry
d. Electromagnetic Emittance (EME)
e. Contamination
f. Fault protection
g. Environment
h. Software
i. Interface requirements between components within the instrument element (interface requirements to Spacecraft will be in ICDs)

SE-5 Field Programmable Gate Array (FPGA) Development Plan

Description:

Document the vendor's systematic approach to, and processes used in: the management, design, development, testing (verification, validation, and qualification), documentation, configuration management, review and quality assurance of any Field Programmable Gate Arrays (FPGAs). The FPGA Development Plan shall apply to all FPGAs developed by the vendor for the GDC Flight Project *and digital logic functions in ASIC devices as necessary*.

Reference: 500-PG-8700.2.8A Field Programmable Gate Array (FPGA) Development Methodology

Content:

The Firmware Development Plan shall address:

1. Required documentation (requirements, specification)
2. FPGA development flow diagram
3. Test and flight FPGA part types selection, justification and usage
4. Use of 3rd party or government developed FPGA designs (design-reuse) and/or intellectual property code (includes core selection, management and verification)
5. FPGA design capture process
6. FPGA verification plan, including:
    a. Simulation
    b. Any other analysis methods
    c. Non-flight hardware test configuration(s)
    d. Flight test configuration(s)
7. FPGA computer-aided engineering (CAE) tools including version number
8. FPGA utilization/margin guidelines at specified stages of development for I/O, combinatorial logic, sequential logic, RAMs, cores, etc. as well as internal and interface timing
9. Design Review process – Reviews specified may be combined with in-house FPGA reviews
    a. Each FPGA design (including unmodified designs): Provide for one NASA independent peer review, prior to programming the flight parts (pre-burn review)
    b. Each new or modified FPGA design: Provide for one additional NASA independent peer review, concurrent with testing of flight candidate design but sufficiently prior to programming the flight design to accommodate possible design revision and re-test
10. Quality Assurance involvement/monitoring/oversight/audit of FPGA development processes
11. Revision control, configuration management and archive processes used at specified stages of development.

SE-6 FPGA Data Design Package

Description:

An FPGA Data Design Package (FDDP) is required for each FPGA design to allow independent government review of vendor FPGA designs. An FDDP shall be submitted for each FPGA design used by the vendor for the GDC Flight Project *and ASICs employing digital logic functions, as necessary*. If an FPGA is revised after its FDDP was delivered, then an updated FDDP shall be delivered so that each FPGA's final FDDP contains the flight design.

Reference: 500-PG-8700.2.7B: Design of Space Flight Field Programmable Gate Arrays

Content:

The FDDP shall include:

1. Design (place and route) database
2. Synthesis report files
3. Circuit board schematics containing this Gate Array
4. Circuit board netlist(s) (any ASCII format such as PADS, MGC, Allegro)
5. Requirements, specifications, and verification document(s) as well as any supporting material (e.g., block diagrams, presentation material) relevant to the Gate Array
6. Source code (e.g., VHDL, Verilog, state machines, state tables PDF of schematics) including any 3rd party intellectual property code and/or cores
7. Responses to the 500-PG-8700-2.7B (Design of Space Flight Field Programmable Gate Arrays) checklist or equivalent including:
    a. Timing analyses for external inputs and outputs, internal domain(s), etc.
    b. Disposition of all clock domain crossings
    c. Simulation analysis summary (e.g., functional coverage, code coverage) and simulation testbench/script code
    d. Signal integrity analyses relevant to this Gate Array
    e. Power integrity analyses relevant to this Gate Array

To facilitate reviewing the FPGA design, the developer may include:

1. System, box, and circuit board requirements, specifications, presentations, and/or verification document(s) relevant to the Gate Array and its role in the system, box, and circuit board
2. Board part list (any ASCII or common spreadsheet format)
3. PDF of the board layout, such as an assembly drawing
4. Any other files relevant to the review of the Gate Array

SE-7 Calibration Data Records

Description:

Provides a record of instrument performance for predicted flight environments.

Content:

A digital history record will be provided, which will be stored on some form of mutually agreed upon media, and will contain all instrument output data plus any ancillary data necessary for the use of the instrument data. All media shall be provided by the contractor. These records shall be identified by date, test particulars and location on the storage media.

Calibration Data Records shall be the documentation associated with the calibration and development of the Instrument performance models. Data will be delivered on-site and shall be available for inspection. Reports consisting of a description of the final performance and the process of reduction ('Calibration Report') for validation of the science requirements will be delivered along with the End Item Acceptance Data Package.

SE-8 Input to Interface Control Documentation

Description:

An Interface Control Document (ICD), developed by the spacecraft contractor, will be used to define the spacecraft to instrument electrical, mechanical and thermal interface requirements. Additionally, a Mechanical Interface Control Drawing (MICD) will be used to define the precise instrument and instrument dedicated hardware location relative to the spacecraft.

Content:

The instrument shall provide detailed information regarding the instrument payload interface to the spacecraft bus. The data provided shall be in the form of written words, drawings, and schematics, which will be incorporated into a spacecraft-generated spacecraft bus to instrument IRCD/ICD for applicable signatures.

The spacecraft bus to instrument interface is defined per the following topics as a minimum:

1. Physical Requirements – such as materials, mass properties, dynamic propulsion (angular momentum, disturbance torques), footprint, clearance envelope, drill template, alignment, orientation, fields of view (optical, thermal, glint, RF), including tolerances, and special accesses. Electrical Connectors - regarding sex, type, orientation, pin assignments. Thermal control coatings, blankets, heat flow and operating limits. Red and green tag items for test and flight. Instrument access requirements for views (e.g., to alignment cubes, calibration sources, etc.), lifting points, purge ports including T-0, or any others will be defined in the ICDs.

2. Electrical Power and Signals - such as timing clock pulses, data busses, signal (name, type, function), voltage and current limits, frequencies, waveforms, rise and fall time, duration, periodicity, shielding, grounding, formats, fusing, voltage, currents, ripple, regulation, impedance, and isolation.
3. Software - Content defined in GDC Software Management Plan.
4. Payload Environmental – such as vibration, shock, acoustic, EMI/EMC, magnetic, ESD, thermal, contamination, purges.
5. Safety - such as pyrotechnics, energy storage, trip-over, hazardous materials.
6. Ground Support Equipment - such as mechanical, electrical, thermal, test specific, targets, stimulators.
7. Operational Factors – such as ground contacts needed per day, data storage capacity, general flight rules and limitations.
8. Cabling and RF Waveguide - such as routing support brackets, and dummy loads.
9. Contamination Control – such as cleanliness levels, purge requirements, handling during Observatory I&T.

Sufficient detail shall be shown on both sides of each interface to provide clear and complete documentation of the resultant mated interface. For example, electrical interfaces should be presented in schematic detail (logic elements and piece parts) to the point where impedance and transfer characteristics are fully described.

SE-9 Input to GOLD Rule Compliance Matrix

Description:

The GSFC Rules or Goddard Open Learning Design (GOLD) Rules specify sound engineering principles and practices for the Design, Development, Verification, and Operation of Flight Systems. The process for assessing compliance to, reporting on, and deviating from adherence to these design guidelines is defined in and governed by GPR 8070.4.

Content:

The instrument input shall support project generation of all products required by GPR 8070.4 including, but not limited to, a matrix detailing instrument adherence to GSFC-STD-1000G, Goddard Space Flight Center Rules for the Design, Development, Verification, and Operation of Flight Systems, dated August 3, 2009 and any waiver/deviation requests for items of non-compliance.

SE-10 Computer Aided Design (CAD) Models

Description:

Instrument providers shall provide CAD models at various levels of development including the final flight configuration for hardware unit and assembly deliverables. The CAD models shall include all part files, drawing files and assembly files. Final configuration CAD files shall be delivered along with the End Item Acceptance Data Package.

Content:

1. CAD models shall have a defined coordinate system and assigned materials with accurate mass properties values
2. Complete units and assemblies should not have subcomponents modeled in separate CAD system formats. To prevent file import and merging errors, the instrument system should be modeled using only one CAD system format. Additionally, all files provided to the project for a specific unit/assembly shall have the same CAD system format.
3. CAD files shall be readable in project specified external viewers (such as edrawings, creo view, adobe PDF, etc.)
4. CAD files shall be delivered in a GDC project supported CAD system format.
5. Native format CAD files shall be embedded in all drawings; Part drawings shall be supplied in pdf format with a step file attached to the pdf.

SE-11 Coordinate Systems Document

Description:

The Coordinate System Document establishes a common reference frame.

Content:

The Coordinate System Document defines all relevant (down to the component-level) coordinate systems, numbering conventions, boresight/spin vectors, and rotational polarities, and relates them back to a common coordinate system.

SE-12 Instrument Development Plan

Description:

The Instrument Development Plan describes the instrument provider's approach to designing, building, verifying, and delivery of the required number of flight instruments to ensure quality and performance standards are met on all units within the required schedule and resources.

Developmental units include, but are not limited to: Engineering models, prototype units, flight units, etc.

Content:

The plan shall include:

A description, including the quantity and purpose of, all planned developmental units.

A description of proposed design guidelines and analyses that will be employed/performed to ensure that environmental factors such as: atomic oxygen, radiation, magnetic cleanliness, electrostatic cleanliness, contamination, and surface charging requirements will be met.

A description of the instrument providers sparing philosophy. The description shall include a list of flight spare parts and ground equipment spare parts to be procured for the science investigation that is consistent with the project sparing policy.

Investigators shall include a parts management plan which addresses lead times for all EEE parts and mitigates risks of long lead parts failures.

A manufacturing plan for building multiple instruments. The manufacturing plan shall include a description of design approaches that will ease manufacturability.

A description of verification/validation methods for each development unit.

A description of test plans, including environmental and calibration testing, for each development unit. Include a description of test equipment, test facilities and approach for testing multiple flight units.

For the delivery of flight units, a description of the plan for capturing and applying lessons learned for the effective production of subsequent flight units.

SE-13 Digital Electronics Signal Integrity and Power Integrity Analysis

Description:

This analysis examines signal integrity and power integrity for selected on-board nets and board-to-board nets of the Digital Electronics. The analysis ensures that switching excursions are properly controlled, such that the signal at any device input does not exceed its maximum voltage specification, and that any crosstalk between unrelated nets is minimized. A test report shall be delivered to the project 60 days prior to ICDR.

Content:

The analysis report shall include:

1. A description of analyses to be performed, along with the objective, scope, a description of the test article being analyzed and identification of circuits to be analyzed
2. Applicable documents
3. Requirements to be meet, analyses assumptions, testing limits, Pass/Fail Criteria, and methods of inspection and verification.

4. A description of the test configuration including: configuration of test article, description of test equipment, test environment and description of analysis environment (scripts, software, simulation modeling approaches).
5. A summary of results (including Individual Simulation Results) and file naming conventions, file types and locations.
6. Applicable figures and tables
7. List of acronyms

Test parameters covered by analyses may include:

1. Characteristic Impedance
2. Crosstalk
3. Trace Widths
4. Routed Layers
5. Overshoot
6. Undershoot
7. Monotonicity
8. Ringback

SE-14 Risk Management Plan

Description:

The Risk Management Plan describes the methods and procedures the contractor uses to implement a systematic and iterative process that efficiently identifies, analyzes, plans, tracks, controls, communicates, and documents risks associated with implementation of designs, plans, and processes.

Reference Documents

1. NPR 7120.5E, NASA Spaceflight Program and Project Management Requirements
2. NPR 7123.1B, NASA Systems Engineering Processes and Requirements
3. NPR 8000.4B, NASA Risk Management Procedural Requirements
4. GSFC GPR 7120.4D, Risk Management

Content:

The plan shall describe the developer's plan to implement a continuous risk management (CRM) process to allow risk-informed decision making (RIDM) as an integrated part of

instrument development activities, where RIDM informs systems engineering and management decisions through better use of risk and uncertainty information in selecting alternatives and establishing baseline requirements.

The plan should:

1. Describe the CRM implementation over the course of the development and the implementation phase of the project life cycle to ensure that safety, technical, cost, and schedule requirements are met.
2. Describe the risk management board organization and personnel responsibilities.
3. Describe the approach for the identification, assessment, and ranking of instrument risks, and the conformance of this approach with those identified in NASA Continuous Risk Management guidelines as detailed in NASA GPR 7120.4D (Risk Management). Any tailoring or deviation from NASA GPR 7120.4D shall be specifically identified, along with the rationale for the deviation.
4. Include a description of the risk likelihood and ranking metrics, as well as the method of documenting and updating risks and the frequency in which this occurs.
5. Describe the plan for the tracking and communication of risk within the instrument team and reporting to the GDC project management team, including communication approach and frequency.

SE-15 Verification and Validation (V&V) Plan

Description:

The purpose of the V&V Plan is to identify the activities that will establish compliance with the requirements (verification) and to establish that the instrument system will meet the project's expectations (validation).

Content:

The plan shall:

1. Show instrument system requirements flowdown from level 2.
2. Describe instrument system architecture.
3. Describe instrument verification and validation methods
4. Provide performance verification matrices (that map performance and design requirements/parameters against the verification methods). Include the level of verification, test procedure reference and, when applicable analysis documents to prove compliance with the system specifications.
5. Describe the instrument system design and verification and validation flow.

6. Describe V&V activities that will be applied to the lower-level subsystems/elements/end items.
7. Describe V & V activities that will be performed at the instrument system level and at the observatory level after all its assemblies are integrated.
8. If applicable, describe exceptions to (ambient and thermal vacuum environment) end-to-end performance testing. Provide information on the restrictions and rationale.

SE-16 Observatory Level Test, Verification, and Calibration Reports

Description:

For instrument specific testing at Observatory Level, test reports should be provided after testing.

Content:

Reports should include:

1. An executive summary of the results.
2. Brief overview of the test and test conditions.
3. Identify any anomalous behavior and problem reports generated during the test.
4. Describe any problem resolution, if completed.
5. Include performance data or graphs.
6. Supply supporting data to the project or identify the location of supporting data.

SE-17 Input to Project Systems Engineering Management Plan

Description:

The contractor shall provide inputs to the GDC project SEMP, which describes all aspects of the systems engineering effort throughout all phases of the Project. The purpose of the SEMP is to document, clarify and communicate the systems engineering effort.

Content:

The SEMP will include descriptions of all systems engineering processes and functions, system analysis tasks and the tools to accomplish these tasks, the methodology to monitor technical progress, and how systems engineering supports the time-phased activities of the GDC project.

The project SEMP shall comply with both GPR 7123.1 Systems Engineering, and NPR 7123.1C, NASA Systems Engineering Processes and Requirements.

SE-18 Engineering Drawing, Trees and Lists

Description:

To provide layouts and engineering drawings to serve as the basis for technical discussions, evaluations, manufacturing, fabrication, assembly, test, operations and maintenance. To also satisfy the Observatory drawings requirements of the launch services provider.

Content:

NASA shall be able to access (upon request, within 24 hours) all engineering drawings used to procure, manufacture, assemble, integrate, test and control interfaces. Included in this engineering drawing package shall be all reference type drawings such as layouts, schematics, diagrams, mechanical drawings, electrical schematics, logic diagrams, and block diagrams. The logic diagrams shall cover the system, subsystem and component electronics and shall identify the signal inputs and outputs, internal signal flow, and the next level external connections.

Sketch type drawings shall not be used. Interface control drawings and applicable payload layouts shall include the stowed, extended, and critical intermediate positions of the moving mechanical assemblies and deployable assemblies with respect to fields of view and surrounding structure, components or other hardware. All drawing changes and change notices are included under this requirement.

This delivery includes wiring diagrams. These wiring diagrams shall cover the system, subsystem, component electronics, and interface with electrical/mechanical ground support equipment. It shall identify each wire by its classification:

1. Ground (differentiate between power return, shield, and chassis grounds)
2. Signal
3. Power
4. Wire type, ratings, material, etc.
5. Connector/Backshells
6. Harness bundle braids and termination w/backshell
7. Harness between subsystems and EGSE

The diagrams shall trace each wire's runs identifying all path connections (by connector/pin number). Wire designators shall be clearly delineated for legibility.

An indentured drawing list (including drawings from subcontractors) shall be provided to the Government. An explanation of company procedures for locating drawings in this package shall be provided with this list.

All engineering drawings shall be delivered in the contractor's designated format.

Drawing Trees shall be provided to the Government to show quick-reference relationships between drawings and next level of assembly. One set for the flight hardware, and one set for the EGSE is sufficient. The drawing trees shall also include parts lists, firmware, and PROM versions.

SE-19 Analyses

Description:

To provide detailed analyses and margins of safety calculations for all major components and functions.

Content:

Among other content, the following information shall be provided (as applicable):

1. Structural, mechanical stress analysis, and mathematical analysis, including modal analysis
2. Load Transformation Matrices for coupled loads analysis
3. Inputs to Jitter analysis, including base motion jitter analysis at Instrument to Spacecraft interfaces.
4. Thermal analysis
5. Power load analysis for various instrument modes
6. Surface charging analysis
7. Venting analysis
8. Dynamic Clearance Analysis
9. Torque Margin Analysis
10. Signal Integrity and Power Integrity

The Contractor shall describe the analysis method used, its constraints and execution, limiting cases, and the analysis results.

5.0 FLIGHT SOFTWARE (FSW)

The flight software deliverables described in this section apply if the instrument has a computer (CPU, memory) and software that is written in computer language like C, C++, JAVA, ADA, BASIC, Python, Pearl, etc. or Assembly Language.

For the documents listed in this section, include an alphabetized list of definitions for abbreviations and acronyms. Include an alphabetized list of definitions for special terms used in the document, i.e., terms used in a sense that differs from or is more specific than the common usage for such terms.

The content for the documents described in this Flight Software section, SW-, can be included in other Instrument (PM- or SE-) level documentation or combined together. The * symbol next to an item in this section will indicate that these items are good candidates to be included in other documents.

SW-1 Software Development Plan (SDP)

Description:

This document describes the Contractor's overall systematic approach to managing the processes used in the design, development, testing (all phases), documentation, configuration management, risk management, quality assurance, safety, and transition of each instrument software CSCI (Computer Software Configuration Item).

SDPs are required for every project because they provide the overall view of the software development and management effort. However, plans should be written to a level of detail appropriate for and commensurate with the size, complexity, risk, and required safety of the software. When writing the SDP, small projects may choose to incorporate other plans, such as the software assurance plan or the configuration management plan, in the SDP.

Content:

The Software Development Plan shall include the following topics:

1. Purpose and Description;
2. Software programming/coding language(s) used and tools;
3. Source Lines of Code estimates and Software re-use plans;
4. Software Release (Build) Plan, with estimated delivery dates;
5. Project organizational structure showing authority and responsibility of each organizational unit, including external organizations*;
6. Work breakdown structure of the life cycle processes, budgets, staffing, acquisition approach, physical resources, software size, and schedules associated with the tasks*;

7. Management of safety, security, privacy, and other requirements of the software products*;
8. Verification and validation approach;
9. Acquirer involvement;
10. User involvement;
11. Software Quality Assurance. This section must include the following:
    a. The procedures, reviews, and audits required to accomplish software assurance.
12. Software Configuration Management. This section must include the following:
    a. Responsibilities of software configuration management.
    b. References to the institutional software configuration management policies and directives that apply to the Instrument development project.
    c. All functions and tasks required to manage the configuration of the software, including configuration identification, configuration control, status accounting, and configuration audits and reviews.
    d. Schedule information, which establishes the sequence and coordination for the identified activities and for all events affecting the plan's implementation.
    e. Resource information, which identifies the software tools, techniques, and equipment necessary for the implementation of the activities.
    f. Plan maintenance information, which identifies the activities and responsibilities necessary to ensure continued planning during the life cycle of the project.
    g. Release management and delivery.
13. Risk management*.
14. Security policy*;
15. Approval required by such means as regulations, required certifications, proprietary, usage, ownership, warranty, and licensing rights if any;
16. Process for scheduling, tracking, and reporting*;
17. Software metrics that will be tracked;
18. Training of personnel, including project unique software training needs*;
19. Software life cycle model including description of software integration and hardware/software integration processes, software delivery, and maintenance;
20. Software documentation tree and content of software documentation to be developed
21. Plans for Software peer review/inspection process of software work products;

22. Process for early identification of testing requirements that drive software design decisions; (e.g., special system level timing requirements/checkpoint restart);
23. Delivery and Operational Transition*
24. Post-launch Software Maintenance Plan

SW-2 Software Requirements Specification (SRS)

Description:

The Software Requirements Specification (SRS) specifies all the detailed requirements for the Instrument Flight Software Computer Software Configuration Item (CSCI); including functional and performance requirements, interface requirements, data requirements, quality assurance requirements, testing requirements, security and safety requirements. A traceability matrix shall be included in the SRS that traces each software requirement to a performance specification, system, subsystem, or other higher-level requirement from which it is derived as well as the method which will be used to verify the requirement.

Content:

The Software Requirements Specification shall include the following topics:

1. Instrument System overview, showing sensors and spacecraft data interfaces
2. CSCI (Computer Software Configuration Item) requirements, if applicable:
    a. Functional requirements
    b. Required states and modes
    c. External interface requirements
    d. Internal interface requirements
    e. Internal data requirements
    f. Safety requirements
    g. Performance and timing requirements
    h. Security and privacy requirements
    i. Environment requirements
    j. Computer resource requirements:
        i. Computer hardware resource requirements, including utilization requirements
        ii. Computer software requirements
        iii. Computer communications requirements

k. Software quality characteristics
l. Design and implementation constraints
m. Personnel-related requirements
n. Training-related requirements
o. Precedence and criticality of requirements

3. Qualification provisions (e.g., demonstration, test, analysis, inspection)
4. Bidirectional requirements traceability
5. Requirements partitioning for phased delivery
6. Testing requirements that drive software design decisions (e.g., special system level timing requirements/checkpoint restart)
7. Supporting requirements rationale

For projects with a relatively small number of requirements to document, it may be helpful to use a simple spreadsheet to document and maintain the requirements, traceability and verification method.

- Software requirements and design specifications need not be textual and may include representations in rigorous specification languages, graphical representations, or specifications suitable for requirements or design analysis tools or methodologies.

SW-3 Software Users Manual (SwUM) / Software Design Description Document

Description:

The Software User Manual (SwUM), for the Instrument FSW, shall contain the information required to instruct the user as to how to operate the Instrument FSW. The Software Design Description shall contain software design information.

Content:

Topics to be included in the Software User Manual, if applicable, are:

1. Software summary including:
    a. application
    b. inventory
    c. environment
    d. organization and overview of operation
    e. contingencies and alternate states and modes of operation

f. security and privacy
g. assistance and problem reporting

2. Access to the software:
    a. first-time user of the software
    b. initiating a session
    c. stopping and suspending work
3. Processing reference guide:
    a. capabilities
    b. conventions
    c. processing procedures
    d. related processing
    e. data backup
    f. recovery from errors,
    g. malfunctions
    h. emergencies
    i. messages

4. Instrument FSW Commands Description
    a. For each Instrument FSW Command, describe the function it performs, data patterns, any parameters, criticality, telemetry verification, error conditions and limitations
5. Telemetry and Science Data descriptions
    a. For Telemetry describe its organization, type, ranges, conversion factors, rates.
    b. For Science Data describe its organization, data types,
6. On-Orbit operating constraints.
7. Assumptions, limitations, safety related items/concerns or constraints.

Topics to be included in the Software Design Description Section

1. CSCI - wide design decisions/trade decisions.

2. CSCI architectural design.
3. CSCI decomposition and interrelationship between components:
    a. CSCI components:
        i. Description of how the software item satisfies the software requirements, including algorithms, data structures, and functional decomposition.
        ii. Software item I/O description.
        iii. Static/architectural relationship of the software units.
        iv. Concept of execution, including data flow, control flow, and timing.
        v. Requirements, design and code traceability.
        vi. CSCI's planned utilization of computer hardware resources.
    b. Rationale for software item design decisions/trade decisions including assumptions, limitations, safety and reliability related items/concerns or constraints in design documentation.
    c. Interface design.

The documentation of the architectural design of a software system identifies and describes the architectural elements of the software, the external interfaces, and the interfaces between elements. The description includes element responsibilities (constraints on inputs and guarantees on outputs), and constraints on how the elements interact (such as message and data sharing protocols). The architectural design documentation includes multiple views of the architecture and identifies and supports the evaluation of the key quality attributes of the planned software product. The key quality attributes of the software will depend on the mission in which the software is to be used and the manner in which it is to be developed and deployed. They will usually include: performance, availability, maintainability, modifiability, security, testability and usability (operability.)

SW-4 Flight Software Delivery Package

Description:

Defines the contractor’s responsibility to deliver the software source code, and tools to build the flight images.

Content:

The source code shall be delivered at each release point, and as a final product to be used for analysis by the project.

A software end item data package or software release/delivery package shall be prepared for each software and firmware delivery. The Instrument Provider shall determine the form of the package. As a minimum, the package shall contain the following information:

1. As-built product identification, including:
    a. Identification of software release by program ID, phase, version, date, and build.
    b. Operating system name and version.
    c. Programming language name, compiler name, and version.
    d. Supporting development environment name and version (if any).
2. A Release Description Document (RDD) or equivalent which contains:
    a. Functional Requirements/Capabilities of the build. (SRD)
    b. Instructions or user manual to install and configure the software application, including special test equipment software required to support the primary software application (if any), and identification of all third-party software (TPS) required, operating system and TPS patch levels required, and a software user's guide.
    c. Lists of all software deliverables in this build, including special test equipment software (if any), and hardware configurations used for testing.
3. List of dates and versions of all required documents (under Configuration Management control)
4. List of all waivers applicable to the deliverable items, with a description and rationale for disposition.
5. A list of all open/closed anomalies or liens against. All red-flag anomalies should be closed prior to each delivery review.
6. Verification test procedures/results. For Class B software, Acceptance Test Plan/Procedures/ Report shall be provided.
7. Test Verification Traceability Matrix against software requirements.
8. Executable code for software developed specifically for GDC. Source code, except for those components that are of a proprietary nature.
9. Test reports for acceptance testing.

Updated detailed design shall be made available.

6.0 INTEGRATION AND TEST

IT-1 Instrument Level Integration and Test Plan

Description:

Provide overall view of the Instrument Test Program, detailing test philosophy objectives and rationale for all testing and integration activities planned for the program.

This information will also be used in the development of the Observatory I&T test plan, the Launch Site Support Plan (LSSP) and the Payload Requirements Document (PRD).

Content:

The contractor shall develop a plan to describe each test activity to be performed on the instrument and any constraints that must be observed for the safety of the instrument. It will cover all test operations, including specialized tests such as mechanical function and deployments, environmental exposure tests (i.e., vacuum, vibration), calibration, and Ground Support Equipment (GSE) calibration and checkout.

The plan shall include, but is not limited to:

1. Requirements for GSE, test equipment, and simulators to be used during testing
2. Detailed flow chart showing sequence of testing, including integration and qualification/acceptance activities. Include description of processing multiple units.
3. Envelopes of environments and test levels for components, subsystems, and instrument.
4. Description of facility requirements such as thermal vacuum chamber interface, instrumentation, simulator methods, etc.
5. Descriptions of functional measurements planned, as well as descriptions of methods planned to make the measurements. Describe any unique test configurations.
6. Qualification and acceptance test plans with performance parameter accept/reject criteria
7. Description of when and how frequently all redundant components and cross-strapped paths will be tested during each environmental test activity
8. A list of performance parameters shall be identified that will be used for monitoring stability data trends during the instrument test programs and will be continued during Observatory I&T and mission

IT-2 Packing, Handling, Storage, and Transportation Plan

Description:

The plan for packing, handling, storage, and transportation is intended to assure the safety of the instrument prior to its integration into the spacecraft system. Lifting procedures shall be in compliance with NASA-STD-8719.9, STANDARD FOR LIFTING DEVICES AND

EQUIPMENT. Storage and transportation procedures shall define instrument container requirements, including purge requirements and transportation environmental requirements, including transportation instrumentation such as temperature, vibration, or shock recording devices which are necessary to assure the ongoing proper instrument operation after removal from storage or at the completion of transportation and shall be in compliance with GSFC-500-PG-8715.1.2 ETD Safety Manual.

Content:

The plan shall establish the design, testing, inspection, maintenance, operational, personnel certification, and marking requirements for packing, handling, storage, and transportation of the instrument and associated equipment used in support of observatory I&T. Procedures for individual instrument/component processes that deviate from standard procedures should be clearly presented and explained.

IT-3 Calibration Plan

Description:

The purpose of the calibration plan is to describe the activities required for instrument calibration if needed.

Content:

The calibration plan will:

9. Identify the calibration technique used and how it will be implemented.
10. Identify parameters of interest and pass/fail criteria.
11. Describe critical equipment and/or facilities.
12. Identify when calibration is performed in the instrument level development and integration flow
13. Identify when calibration is performed in the observatory level development and integration flow
14. Describe data products generated.
15. Describe analysis of results to determine pass/fail criteria.

IT-4 Observatory Level Instrument Test Procedures

Description:

The project will need instrument procedures for post-delivery instrument integration. These can include procedures for unique handling activities, integration with flight system and/or

testbed procedures, functional test procedures, support equipment certification and calibration procedures (if any).

Content:

The instrument procedures shall:

1. Follow the project procedure template
2. Include table of contents
3. Identify applicable documents and drawings
4. Provide test configuration information
5. Gather calibration information for tools and equipment
6. Identify unit under test configuration, including serial and part numbers
7. Identify inspection steps
8. Provide sign-off field for each step
9. Identify hazardous steps (if any)
10. Describe data processing activities required to determine the health of the instrument.

IT-5 Command & Telemetry Data Formats

Description:

This handbook will contain information on command and telemetry data formats. It will be used to develop the command and telemetry database for test scripts and telemetry pages. Tables or equations will be needed to translate telemetry into engineering units.

Content:

The handbook will describe telemetry and command bit formats and correlate bits into associated engineering units. Descriptions will be provided to describe instrument operations represented by the telemetry and commands.

IT-6 Support Equipment End Item Data Packages

Description:

The Support Equipment End Item Data Packages (EIDPs) will provide quality assurance information concerning the fabrication and design of support equipment used.

Content:

The EIDP should contain:

1. Assembly drawings
2. Operational procedures or users guide
3. Structural certifications of the completed assembly
4. Electrical certifications of the completed assembly
5. Any safety related equipment must include safety verifications

IT-7 Instrument Constraint Document

Description:

A constraint is an operation which could result in stress, damage or harm to the flight hardware; or result in permanent mission degradation. This document will identify instrument constraint conditions.

Content:

This document should describe violation impacts, mitigation plans, applicable environment (ground vs. flight), and rationale. It may include the following items:

1. Contamination sensitive items
2. ESD sensitive items
3. Hazardous configurations
4. Magnetic sensitive items
5. Integration constraints
6. Limited Life Items
7. Thermal Constraints

7.0 OPERATIONS

OPS-1 Command and Telemetry Handbook

Description:

The command and telemetry handbook provides the commands required for instrument operation and definition of all instrument telemetry data.

Content:

This handbook shall contain a complete list of instrument commands for all instrument modes of operation and sequence testing with a description of their effects, and identification of any critical commands that may damage the instrument in certain situations.

It shall also contain a complete list of telemetry data coming from the instrument, including engineering telemetry calibrations, the levels or responses expected in response to commands, and levels which require alerts or immediate actions.

OPS-2 Operation and Maintenance Manual

Description:

The operations and maintenance manual is for operating and servicing the instrument and it's Ground Support Equipment (GSE).

Content:

Operation and maintenance manuals shall be prepared for the instrument and for all GSE. At a minimum, these manuals shall contain the: system and subsystem description; function and operation block diagrams and circuitry description; operation and test procedures; and maintenance, performance data and instrument operating limits. These manuals, in conjunction with the drawing books, shall provide all the information needed for operating, maintaining, and troubleshooting the instrument and (applicable) GSE.

OPS-3 Inputs to Mission Operations Plan

Description:

The Payload contractor shall provide the necessary inputs into this document so that the Project can complete this requirement. This manual provides a detailed description and plan for performing flight and ground operations of the observatories.

Content:

This manual shall consist of the mission operations concept, flight operations procedures, ground operations procedures, operations interface agreements, ground system interface specifications, observatory operations plans, command and telemetry dictionaries and flight

constraints and restrictions. This manual will include all phases of mission operations from launch and early orbit insertion to disposal.

Requested inputs may include (but are not limited to) instrument description, instrument functional and technical overview, and checkout, initialization and commissioning plans.

OPS-4 Inputs to Mission Concept of Operations

Description

The Payload contractor shall provide the necessary inputs into this document so that the Project can complete this requirement. This document provides an overview of the mission phases and the operations concept, sequence of events and operations timeline during each mission phase. The document serves as a primer for and Volume 1 of the Mission Operations Plan.

Content:

The Mission Concept of Operations shall contain payload descriptions, spacecraft bus descriptions, flight operations overview, general launch and orbit information, mission timeline and phases, and flight rules.

Requested inputs may include (but are not limited to) instrument overview, instrument operational plans during mission phases, and instrument specific flight rules.

8.0 SCIENCE INVESTIGATION

SI-1 Input to Science Data Management Plan (SDMP)

Description:

Describes the science and ancillary data associated with the mission. This document describes how the mission will meet the Level-1 requirements that address distribution of processed science data to the general community.

Content:

One SDMP will be produced for the mission and each investigation team will be required to provide input.

The science teams (Instrument teams, Science teams and Project Scientists) will develop input to the SDMP that defines the data processing approach and implementation, data and documentation products, data availability, and storage and archival strategies. It will also define the access method(s) for the scientific community. Signers of these documents will include the Project Manager, Project Scientist, and each Principal Investigator. Others may also need to sign this plan, depending on the Project-specific situation.

Each data provider will be expected to generate and make available metadata and other supporting material on the data products, spacecraft, and instrumentation appropriate to their investigation. The details of these will be defined during discussions with the Project and Program personnel during the drafting of the SDMP. The intent of such metadata and materials will be to make the data correctly and independently useable for science investigations.

Each SDMP will:

1. Provide and forecast for the mission's long-term archiving of the data and tools. The SDMP will recognize that the final mission archive will be specified in its Mission Archive Plan to be submitted to HQ for approval prior to the termination of the mission.
2. State how that Project will support the broader goals of cross-disciplinary science, to include the use of those data by interdisciplinary scientists
3. State how the ancillary and anecdotal data relevant to the mission will be captured, archived, and made available as part of the mission dataset.
4. State how the mission data will interface to the data environment that is anticipated to exist at the time of launch.

Examples of information that are appropriate for each data provider to include in a SDMP are:

1. Definitions of data (including levels as defined by the mission) and estimates of data volume and frequency
2. Identification of data that are made available to the public
3. Description of the means that data are made available to the public
4. Schedule for making these data available
5. Description of documentation to be provided on datasets, instruments, and spacecraft relevant to data usability
6. Data format specification or references (e.g., FITS, CDF, HDF, Documented ASCII, etc.)
7. Processing and analysis tools that are made available
8. Back-up strategy to be implemented (routine and catastrophic)
9. Reprocessing strategy, if appropriate
10. Ancillary data description, generation, capture, distribution, and storage
11. Engineering telemetry disposition (e.g., capture, distribution, archive)
12. Calibration data description
13. Definitive orbit and attitude data
14. Metadata schemes to be employed, and the relation to the SPASE Data Model
15. Catalogues of data or events that will be produced
16. Technical support that will be provided for data use
17. Description of data documentation to be provided
18. Proposed data distribution capacity
19. Plan for long-term data serving and preservation

SI-2 Inputs to Mission Archive Plan

Description:

A Mission Archive Plan (MAP) will be prepared by the mission team as it enters into its extended phase. Each investigation team will be required to provide input.

The purpose of the plan is to lay out the steps needed to be completed by the mission team to ensure that the appropriate mission data archive has been prepared prior to the termination of the mission.

Content:

The plan will be able to address advances in Information Technology which have occurred since preparation of the PDMP and the development of its data system. Also, the plan will be able to adopt new developments in the architecture of HPDE. The plan will describe the current state of the mission's scientifically relevant data products and describe the steps needed to complete the mission archive, including the final list of products. The MAP may layout a roadmap to creating or using existing resident archives of mission data in the post-operations phase. The implementation of the MAP will be completed prior to planned termination of the mission or soon as possible after an unplanned termination of the mission. The MAP will be submitted as part of a mission's proposal to the senior reviews of the Heliophysics operating missions. Once reviewed by the senior review, the subsequent oversight of the implementation of the plan will be made by mission's Project Scientist. The plan will be updated periodically during the extended phase.

SI-3 Levels 1-4 Data Requirements

Description:

Development and validation of requirements on critical characteristics of data products from Level 1 through Level 4.

Content:

The contractor shall provide inputs to the requirements definition process, providing detailed requirements on the performance / characteristics of data products resulting from the investigation.

For example, this may include:

1. Accuracy of data product
2. Precision of data product
3. Dynamic range of data product
4. Requirements on reference coordinate systems
5. Temporal cadence of data product

SI-4 Algorithms and Verified Code Input to the SOC for Pipeline

Description:

Development of the instrument's algorithms and verified software code that will be used as input to the Science Operations Center (SOC) pipeline.

Content:

The contractor shall prepare the algorithms required for the analysis of the science data from the instrument and develop the software code, including a description of its verification process that will be provided to the SOC. This will also include inputs to the data visualization / analysis tools that will be distributed by the SOC to the community.

SI-5 Inputs to GDC Science Data Product User's Guide

Description:

To provide an easy-to-use single reference for the science community and GDC science team to be able to understand and make use of the data products generated by the mission.

Content:

One science data product user's guide will be produced for the Mission by the Project, and each investigation shall provide the necessary input regarding the data products it produces.

The contractor shall prepare descriptions of the data products generated by their investigation in sufficient detail to permit external users to perform scientific research using these products.

Among other content, this input will include:

1. Description of data products, and high-level description of algorithms used to generate higher-level products from the raw data
2. Discussion of error sources and quality flags used to indicate intervals where data may need more care in interpretation
3. Description of all coordinate systems referenced by these products
4. Details of the data format used to store the data
5. Example software code that can be used to load and display the data products
6. Discussion of validation / calibration that has been performed on the data

SI-6 Instrument Design and Operations Article

Description:

To provide an easy-to-use single reference for the science community and GDC science team to be able to understand the concept of operation of the instrument(s) used in each investigation, as well as their known limitations or unique aspects.

Content:

Each investigation shall develop an article describing the instrument design and operations, in sufficient detail for users in the scientific community to make best use of the investigation data.

Among other content, this input will include:

1. Basic principles of operation for the instrument(s) in the investigation
2. Description of operating modes for the instrument(s)
3. Schedule of normal operations
4. Measurement cadence, dynamic range, accuracy, precision, and any other parameters needed to unambiguously specify the range over which a measurement is valid
5. Basic scheme for calibration and validation
6. Ground-based calibration data
7. On-orbit initial checkout data and an assessment of instrument performance
8. Description of any operating limits that must be observed during instrument operation (e.g. Sun avoidance, operation changes in regions of penetrating radiation, etc.)
9. Description of any onboard processing that occurs in the instrument
10. Electrical block diagram of the instrument subsystems

SI-7 Scientific Publications

Description:

Courtesy copies of science papers written by Science Investigation team members or its subcontractors using GDC funds.

Content:

Papers to be provided after peer review and publication

SI-8 Inputs to Extended Mission Proposal

Description:

The Project, if approved to do so by NASA HQ, will submit an extended mission proposal, and individual Investigations will be required to provide reports about their performance during the Prime Mission, major science results, and outlook / plans for future performance and science targets.

Content:

The inputs to the Project's extended mission proposal will include such items as:

1. Current status and health of instruments
2. Performance of instruments to date

3. Status and availability of L1-L4 data products
4. Archived data status
5. Report on publications and presentations given by the investigation team (funded by GDC)
6. Report on major science results based on data from the investigation
7. Plans/outlook for future instrument performance

SI-9 Science Working Group Report

Description:

The Investigation shall report on the status of science-related preparations relevant to the investigation development on a biweekly basis, via telecon. The investigation will participate in regular "splinter working group" telecons as needed (no more often than biweekly, on alternate weeks with the science working group telecon).

Content:

The inputs shall include such items as:

1. Brief status reporting on planning/modeling studies
2. Brief status reporting of instrument modeling and performance verification modeling
3. Brief status reporting of data processing algorithm and code development
4. Brief status reporting of publication and presentation preparation
5. Support of splinter group science discussions (involving aspects that have impacts on multiple investigations / instruments but perhaps not germane to the whole science team)

SI-10 Science Team Meeting Reports

Description:

The Investigation shall support Science Team meetings (3x / year, 2-3 days per meeting).

Content:

The Investigation shall provide detailed reporting on such items as:

1. Science related planning / modeling studies
2. Instrument modeling and performance verification
3. Data processing and code development

4. Publication and presentation preparation

As well as:

Participating in detailed coordination and planning with other Investigations

SI-11 Phase E Science Planning Telecons

Description:

The Investigation shall participate in weekly science planning telecons beginning at launch and extending through Phase E, to coordinate science operations.

Content:

The Investigation shall participate in weekly science planning telecons from launch through the end of Phase E, which will include:

1. Planning of calibration intervals
2. Discussions of the outlook for future constellation evolution
3. Planning of modifications to instrument operating modes or parameters
4. Coordination with other observing facilities that may be making complementary measurements

9.0 MISSION ASSURANCE

INSTRUMENT MISSION ASSURANCE DID DESCRIPTIONS ARE CONTAINED IN THE GDC IMAR. APPENDIX A ACRONYMS

A	Approval
ACWP	Actual Cost of Work Performed
AFR	Available For Review
AO	Announcement of Opportunity
ASIC	Applications Specific Integrated Circuit
CA	Control Account
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CM	Configuration Management
CPU	Central Processing Unit
CRM	Continuous Risk Management
CSCI	Computer Software Configuration Item
EAC	Estimate at Complete
ECP	Engineering Change Proposal
EEE	Electrical, Electronic and Electromechanical
EGSE	Engineering Ground Support Equipment
EIDP	End Item Data Package
EMC	ElectroMagnetic Compatibility
EME	Electromagnetic Emittance
EMI	ElectroMagnetic Interference
ESD	ElectroStatic Discharge
ETD	Engineering Technology Directorate
EV	Earned Value
EVM	Earned Value Management
FDDP	FPGA Data Design Package
FEA	Finite Element Analysis
FPGA	Field Programmable Gate Array
FRR	Fight Readiness Review
FSW	Flight Software
GDC	Geospace Dynamics Constellation
GFP	Government Furnished Property

GM	Geometric Model
GOLD	Goddard Open Learning Design
GPR	Goddard Procedural Requirement
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HPDE	HelioPhysics Data Environment
HQ	(NASA) Headquarters
IBR	Integrated Baseline Review
ICD	Interface Control Document
ICDR	Instrument Critical Design Review
ID	Identification
ID	Information
IMAR	Instrument Mission Assurance Requirements
IMR	Instrument Monthly Report
IMS	Integrated Master Schedule
IPDR	Instrument Preliminary Design Review
IPER	Instrument Pre-Environmental Review
IPSR	Instrument Pre-Ship Review
IRCD	Interface Requirements Control Document
ISRR	Instrument System Requirements Review
IT	Information Technology
IT	Integration & Test
KDP	Key Decision Point
LSSP	Launch Site Support Plan
LTM	Load Transformation Matrices
MAP	Mission Archive Plan
MDR	Mission Definition Review
MICD	Mechanical Interface Control Drawing
MIS	Management Information System
MOR	Mission Operations Review
MSR	Monthly Status Report
NASA	National Aeronautical and Space Administration
NPR	NASA Procedural Requirement
OPS	Operations
ORR	Operational Readiness Review
PDF	Portable Document Format

PDMP	Project Data Management Plan
PDR	Preliminary Design Review
PER	Pre-Environmental Review
PG	Procedures and Guidelines
PLAR	Post-Launch Assessment Review
PM	Project Management
PMB	Performance Measurement Baseline
PRA	Probabilistic Risk Assessments
PRD	Payload Requirements Document
PROM	Programmable Read-Only Memory
PSR	Pre-Ship Review
R	Review
RDD	Release Description Document
RF	Radio Frequency
RIDM	Risk-Informed Decision Making
SDMP	Science Data Management Plan
SDP	Software Development Plan
SE	Systems Engineering
SEMP	Systems Engineering Management Plan
SI	Science Investigation
SIR	System Integration Review
SOC	Science Operations Center
SOW	Statement of Work
SPASE	Space Physics Archive Search and Extract
SRD	Systems Requirements Document
SRR	System Requirements Review
SRS	Software Requirements Specification
STD	Standards
STOP	Structural, Thermal, OPtical
SW	Software
SwUM	Software User's Manual
TM	Temperature Model
TPS	Third-Party Software
TRL	Technology Readiness Level
TRR	Test Readiness Review
VAR	Variance Analysis Report

WBS Work Breakdown Structure